

■ 18-MONTH ECONOMIC FORECAST • TECHNOLOGY IN THE YEAR 2000 ■

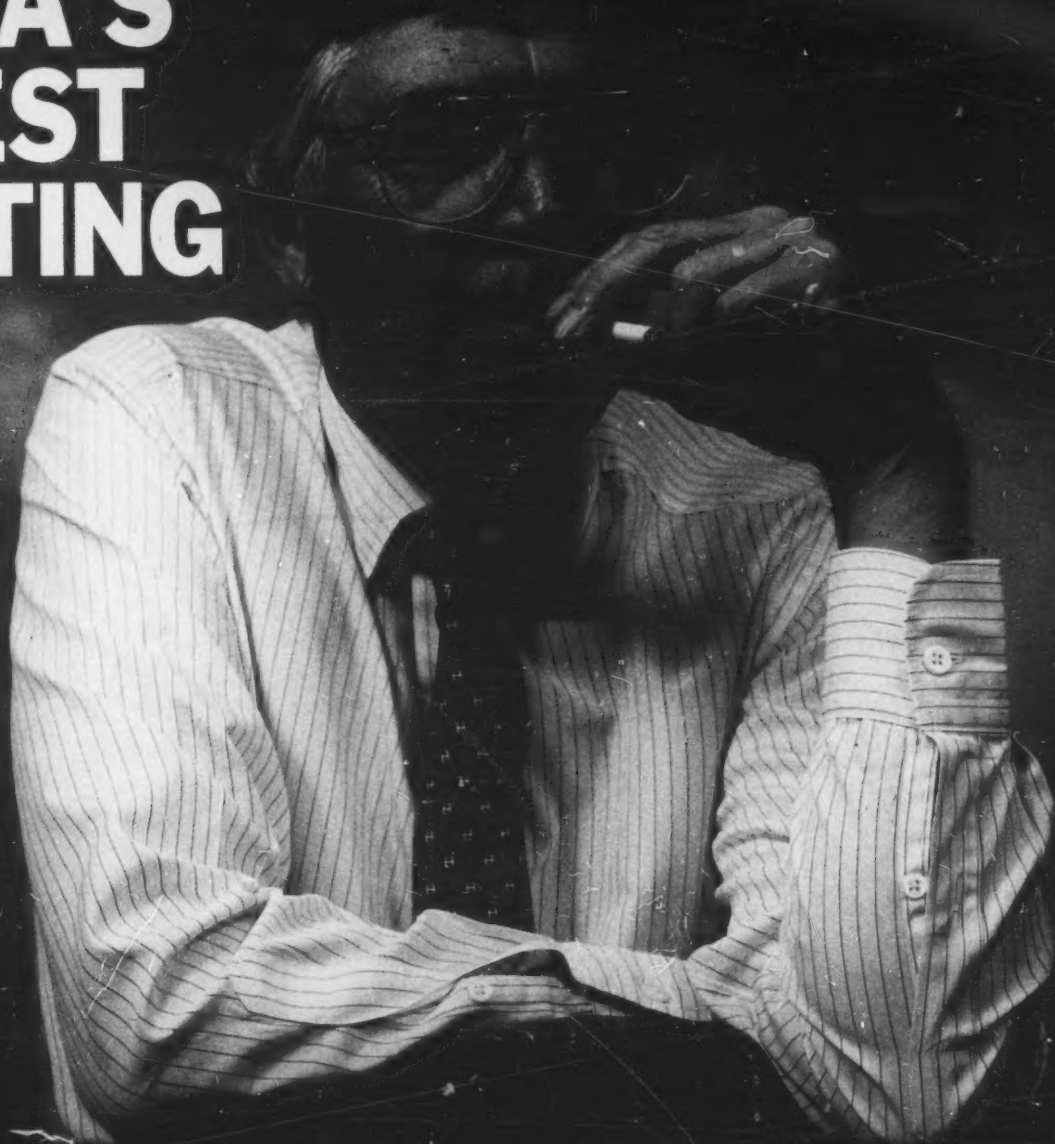
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FORTUNE

AMERICA'S TOUGHEST MARKETING MAN

How
Ross Johnson
Crushes
Competitors
for Fun

Profit



*RJR Nabisco's CEO
flaunts his new
"smokeless" cigarette.*

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JULY 18, 1988

FORTUNE



COVER: Harry Benson photographed CEO Ross Johnson at RJR Nabisco headquarters in Atlanta.

CORPORATE PERFORMANCE Cover Story

THE TOUGH COOKIE AT RJR NABISCO

32

In two mergers, Ross Johnson went through the revolving door last and came out first. An enemy of the quiet life, he reorganizes businesses constantly, reduces staff by the thousands, and shuffles executives like playing cards. Johnson's frenzy seeks a simplified management process with the single goal of pushing the company's powerful brands: Oreo cookies, Ritz crackers, Life Savers, and Winston cigarettes, among other blockbusters. His philosophy beat Procter & Gamble in the Great Cookie War and should boost earnings per share 20% annually through 1990. *by Bill Saporito*

ROSS THE BOSS SPEAKS OUT

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"You've got to know you can't bat a thousand, and you've got to have the stomach for it."

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THE ECONOMY/18-Month Forecast

RECESSION? DON'T HOLD YOUR BREATH

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Expansions do not just die of old age, and the spending excesses that usually set the stage for a downturn are nowhere in sight for the next year and a half.

by Todd May Jr.

WHO STANDS TO GAIN MOST

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MANAGING

PUSHING CORPORATE BOARDS TO BE BETTER

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Through lawsuits and proxy fights, newly aggressive shareholders are winning more corporate control and are forcing directors to shape up and do their jobs. The stockholder revolution has just begun.

by Stratford P. Sherman

SELLING

THE 50 LEADING U.S. EXPORTERS

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Led by General Motors and Ford, American exporters had a bumper year in 1987 and helped put a noticeable dent in the trade deficit. Even more encouraging, exports continued to climb through the early months of 1988. *by Edward C. Baig*

WEALTH

GREAT FORTUNES LOST

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Think your money and luck will never run out? A multitude of missteps can send the family right back into the proverbial shirtsleeves—and often have.

by Jaclyn Fierman

HOW TO KEEP IT ALL IN THE FAMILY

84

Try spreading the wealth before you die, or use a creative tax scheme called a GRIT.



"The role of the board is not to be a contender against management. Its role is to help management."

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"I always knew, even when I was at the bottom, that I could pick myself up and make it all back again."

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"If the economy strengthens, interest rates rise and stocks lose. If the economy weakens, earnings fall and stocks lose."

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"Sanctions and disinvestment worsen our position and set the clock back. They are madness!"

PAGE 88



"Forget the unexpected—the unexpected will just accelerate the progress. Believe me, we're having a revolution."

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"If I can give \$4 million or \$5 million to charity because I write a book, I may have that obligation to myself."

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MONEY & MARKETS

FRESH WARNINGS OF A BEAR MARKET

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Despite rising stock prices, a disturbing number of professional investors are ducking for cover these days. This is not a bull market struggling to regain its footing, they contend—but a big bad bear that will drag stocks down further and maul investor wealth yet again. Though they differ on the market's exact course in the months ahead, most of these pros agree that last October's slide was just the beginning. *by John J. Curran*

POLITICS & POLICY

WHAT THE U.S. MUST DO IN SOUTH AFRICA

88

America's anti-apartheid policy has backfired, hurting the people it was intended to help. Disinvestment and trade sanctions, instead of ending the abomination of apartheid, are inspiring the Pretoria government to roll back reforms. Worse, they are moving the white electorate still further to the right, raising the specter of a more racist and reactionary government. But what should replace the U.S. policy? The debate is heating up in Washington. *by Marshall Loeb*

LOOKING AHEAD

TECHNOLOGY IN THE YEAR 2000

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In the past dozen years the personal computer has transformed offices; videocassette recorders and compact discs have revolutionized home entertainment; and biotechnology has conferred genetically engineered vaccines and a host of other benefits on mankind. What further wonders lurking in the labs today will be commonplace when the next century begins? Exults one Silicon Valley executive: "We'll see a minimum of ten times as much progress in the next 12 years as we've seen in the past 12." *by Gene Bylinsky*

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EDITOR'S DESK

AFTER A YEAR or so of popular doomsaying, the new vogue among economists is optimism. They are finally recognizing what FORTUNE chief economist Todd May Jr. and his staff have predicted all along: Calamity Jane will not be visiting anytime soon. Beginning on page 48, May and his fellow prognosticators, notably economists Vivian Brownstein and Maureen Allyn, once again tell what to expect from the U.S. economy for the next 18 months.

To make our forecast of growth, unemployment, inflation, and profits, we use our own computerized economic model. FORTUNE is the only magazine to have one, and the results show why the investment has been worthwhile. "We never succumbed to the recession virus, even after the stock market crash," says May. He believes the economy will keep ticking along nicely, though inflation may become a problem by the end of next year.

Looking still further ahead, I commend to you Gene Bylinsky's dazzling preview of technology in the year 2000 (page 92). His picture of the coming revolution in computers, medicine, communications, and materials science will make armchair futurists impatient for the new century.

Equipped with our latest projections and a few tips from our Personal Investing department (on page 21), you might be able to parlay an embryonic investment into a nest egg. But people don't always make money. They lose it too, and sometimes they lose fortunes. Tales of legacies lost always have the power to fascinate. The wealthy among us want to know the pitfalls to avoid, and the rest wonder how folks who have it so good can lose it all so quickly. Associate editor Jaclyn Fierman, along with reporter Reed Abelson, set out to find the most instructive stories. They discovered fortunes abdicated and fortunes lost through incompetence, arrogance, or just plain bad luck (see page 74).

Fierman didn't know it at the



Wealth watcher Jaclyn Fierman

time, but she began her research for this story more than a decade ago in Italy. For two years she studied art history, including the lives of the Medici family, the epitome of Florentine wealth. To our enrichment, she abandoned her goal of a career in art restoration and turned to writing. After earning a master's degree in journalism from Columbia University and working for a number of newspapers and magazines, Fierman joined FORTUNE in 1982.

Her stories since then have often touched on the rewards and responsibilities of wealth. Two years ago she wrote about the marketing prowess of the winemaking Gallo family—and some difficulties they may have in passing the business on to the next generation. Last year she investigated what it takes to be rich in America. "The people who really make it and keep it don't live like millionaires," says Fierman. "They lead relatively humble lives. They don't even know the Joneses."

Randall Loh
MANAGING EDITOR

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THE 50 LEADING U.S. EXPORTERS

Led by General Motors and Ford, American exporters had a bumper year in 1987. The declining dollar helped spur a turnaround and shrink the deficit. ■ by Edward C. Baig

PUMPED UP by the declining dollar, the 50 biggest exporters in FORTUNE's annual directory are aiming some hard lefts at the U.S. trade deficit. At \$142 billion, the deficit remains a formidable opponent—and will for some time to come. But the U.S. is starting to win a few rounds on points.

Consider: Exports by the top 50 rose 8% to nearly \$80 billion in 1987. Total U.S. exports rose further still, climbing 11% to \$253 billion—the largest one-year increase this decade. For the first time since 1981, the growth in exports kept pace with the growth in imports. Even more encouraging, exports continued to climb through the early months of 1988, reaching \$29 billion in March, the highest monthly figure ever.

Why such a spurt of good news? Exporters are finally beginning to feel the effects of the declining dollar, which began its fall in 1985. "The weak dollar is leaving its mark," says Commerce Department economist Jeffery Lins. "It just took time for orders to get through and goods to get shipped." The hot exports last year—auto parts, electronic components, computers, chemicals, and other industrial products—accounted for \$200 billion, about 80% of U.S. shipments abroad. But even farm products made a comeback; down for three years, they rose 10% to \$29 billion.

General Motors leads FORTUNE's list for the sixth straight year, besting its cross-town rival and new runner-up, Ford Motor. GM's exports were \$8.7 billion, a 4% improvement over 1986 but a bit short of its 1985 record of \$8.9 billion. Ford bumped Boeing out of second place on a 5% rise to \$7.6 billion. GM, Ford, and Chrysler (No. 8) don't engage in much long-distance trade; mostly they ship body parts, chassis, and other components to assembly plants in Canada. Last October,



On the rack: GM truck bumpers bound for Canada

President Reagan and Canadian Prime Minister Brian Mulroney signed a trade agreement that, among other things, should keep in place duty-free auto exports between the two countries.

Three of the eight aerospace companies on the list took a nose dive. Boeing lost more than \$1 billion in export sales and fell to third place, largely because it sold fewer 747s abroad. Lockheed, which dropped 14 places to No. 41—the biggest swoon on the list—delivered fewer C-130 Hercules transport planes and P-3 antisubmarine aircraft. Northrop, No. 32 last year, has been winding down sales of its F-5 fighter to Saudi Arabia and some 30 other countries, and dropped off the list entirely.

Four new companies joined the top 50, including Cummins Engine and Xerox. The other two are chemical companies that profited from both the lower dollar and higher commodity prices. Hoechst Celanese, formed when Celanese merged with American Hoechst in early 1987, appeared as No. 32 (by itself, Celanese was No. 35 last year). And Ethyl, which makes petroleum and specialty chemicals, was No. 49. Chemical shipments were so strong that two oil com-

panies, Exxon and Amoco, attributed most of their export rise to demand for petrochemicals. Alas, the nation's pedal-to-the-floor demand for oil and gasoline caused energy imports to jump 18% to \$46 billion.

Favorable prices and the cheap dollar also put paper producers on a roll. Exports rose 46% at International Paper and 24% at Weyerhaeuser. A construction boom in Japan helped account for more than \$800

million of Weyerhaeuser's \$1.2 billion in exports of wood products.

The lower dollar had perhaps its most dramatic effect on electronics and computer companies. All eight electronics firms on the list had higher exports, and the seven computer companies registered double-digit increases. Honeywell, which had the second-largest decline last year, had the second-biggest advance this time. Its 51% increase mainly reflects its acquisition of Sperry Aerospace at the end of 1986. The marriage between Burroughs and Sperry the same year accounts for the even larger gain—60%—at Unisys.

The export figures change from year to year, of course, but the cast of leading characters has remained fairly stable. Twenty-three companies on this year's list appeared on the first FORTUNE compilation in 1980. Another measure of stability: Prime Computer. Seeking to protect itself from an economic downturn in any one part of the world, the Massachusetts producer of computer-aided design and engineering equipment got almost half its sales from exports. For the third year in a row, that was the biggest proportion on the list. ■

RANK	COMPANY	PRODUCTS	EXPORT SALES		TOTAL SALES		EXPORTS AS PERCENT OF SALES		
			\$ Millions	Percent change 1986-87	\$ Millions	Fortune 500 Rank	Percent	Rank	
1987	1986								
1	1	GENERAL MOTORS Detroit	Motor vehicles and parts	8,731.3	4.4	101,781.9	1	8.6	37
2	3	FORD MOTOR Dearborn, Mich.	Motor vehicles and parts	7,614.0	5.1	71,643.4	3	10.6	30
3	2	BOEING Seattle	Commercial and military aircraft	6,286.0	-14.2	15,355.0	20	40.9	2
4	4	GENERAL ELECTRIC Fairfield, Conn.	Aircraft engines, medical systems	4,825.0	11.0	39,315.0	6	12.3	23
5	5	INT'L BUSINESS MACHINES Armonk, N.Y.	Computers, related products	3,994.0	30.6	54,217.0	4	7.4	41
6	6	E.I. DU PONT DE NEMOURS Wilmington, Del.	Specialty chemicals, energy products	3,526.0	19.1	30,468.0	9	11.6	29
7	8	MCDONNELL DOUGLAS St. Louis	Aerospace and information systems	3,243.4	15.6	13,146.1	26	24.7	5
8	7	CHRYSLER Highland Park, Mich.	Motor vehicles and parts	3,052.3	8.6	26,257.7	10	11.6	26
9	10	EASTMAN KODAK Rochester, N.Y.	Photographic equipment and supplies	2,255.0	10.3	13,305.0	25	17.0	12
10	11	CATERPILLAR Peoria, Ill.	Heavy machinery, engines, turbines	2,190.0	8.6	8,180.0	48	26.8	4
11	9	UNITED TECHNOLOGIES Hartford	Jet engines, helicopters, cooling equip.	2,071.0	-2.6	17,170.2	15	12.1	25
12	14	DIGITAL EQUIPMENT Maynard, Mass.	Computers, related products	1,921.0	41.8	9,389.4	38	20.5	7
13	15	PHILIP MORRIS New York	Tobacco, beverages, food products	1,700.0	30.8	22,279.0	12	7.6	40
14	12	HEWLETT-PACKARD Palo Alto, Calif.	Computers, electronic equipment	1,596.0	13.6	8,090.0	49	19.7	8
15	13	ALLIED-SIGNAL Morristown, N.J.	Aircraft and vehicle parts, chemicals	1,416.0	4.3	11,597.0	28	12.2	24
16	16	OCCIDENTAL PETROLEUM Los Angeles	Agricultural products, coal	1,316.0	20.5	17,096.0	16	7.7	39
17	19	MOTOROLA Schaumburg, Ill.	Semiconductors, radio equipment	1,303.0	22.8	6,707.0	62	19.4	10
18	29	UNISYS Blue Bell, Pa.	Computers, related products	1,198.4	59.9	9,712.9	36	12.3	22
19	23	WEYERHAEUSER Tacoma	Wood, pulp, paper, logs, lumber	1,159.0	24.4	6,989.8	58	16.6	13
20	22	GENERAL DYNAMICS St. Louis	Tanks, aircraft, missiles, gun systems	1,156.9	15.3	9,344.0	39	12.4	21
21	28	EXXON New York	Petroleum, chemicals	1,129.0	46.4	7,641.6	2	1.5	50
22	18	WESTINGHOUSE ELECTRIC Pittsburgh	Generating equipment, defense systems	1,096.0	1.6	10,679.0	33	10.3	31
23	17	UNION CARBIDE Danbury, Conn.	Chemicals, plastics	1,064.0	-2.5	6,914.0	59	15.4	15
24	20	RAYTHEON Lexington, Mass.	Electronic defense systems, aircraft	1,047.0	-0.9	7,659.4	53	13.7	19
25	21	ARCHER DANIELS MIDLAND Decatur, Ill.	Protein meals, vegetable oils, flour	981.7	-3.2	5,774.6	71	17.0	11
26	24	DOW CHEMICAL Midland, Mich.	Chemicals, plastics, polymer products	978.0	8.2	13,377.0	24	7.3	42
27	26	TEXTRON Providence	Aerospace and consumer products	891.0	13.4	5,561.4	72	15.7	14
28	25	MONSANTO St. Louis	Herbicides, chemicals, pharmaceuticals	887.0	1.6	7,639.0	55	11.6	28
29	36	INTERNATIONAL PAPER Purchase, N.Y.	Pulp, paper, wood products	777.0	45.8	7,763.0	52	10.0	32
30	31	ITT New York	Logs, cellulose pulp	719.0	14.1	8,551.0	45	8.4	38
31	33	MINNESOTA MINING & MFG. St. Paul	Industrial, electronic, and health prod.	673.0	12.5	9,429.0	37	7.1	44
32	•	HOECHST CELANESE Somerville, N.J.	Chemicals, plastics, fibers	672.0	N.A.	4,596.0	91	14.6	18
33	34	FMC Chicago	Defense equipment, chemicals	612.9	3.1	3,139.1	137	19.5	9
34	43	HONEYWELL Minneapolis	Control systems, flight systems	581.0	51.3	6,679.3	63	8.7	36
35	46	INTEL Santa Clara, Calif.	Microcomputer components and prod.	537.7	46.9	1,907.1	200	28.2	3
36	37	ROCKWELL INTERNATIONAL Pittsburgh	Electronic equipment, automotive parts	503.0	2.0	12,123.4	27	4.2	45
37	47	MERCK Rahway, N.J.	Drugs, specialty chemicals	492.0	35.2	5,061.3	80	9.7	33
37	39	AMOCO Chicago	Chemicals	492.0	15.8	20,174.0	14	2.4	49
39	30	DRESSER INDUSTRIES Dallas	Energy-related equipment	475.4	-26.8	3,119.7	138	15.2	17
40	41	PRIME COMPUTER Natick, Mass.	Computers, related products	464.0	14.2	960.9	334	48.3	1
41	27	LOCKHEED Calabasas, Calif.	Aircraft, electronic and info. systems	456.0	-41.8	11,370.0	30	4.0	46
42	42	CONTROL DATA Minneapolis	Computers, related products	445.6	14.4	3,366.5	123	13.2	20
43	•	CUMMINS ENGINE Columbus, Ind.	Diesel engines and parts	425.0	24.3	2,767.4	148	15.4	16
44	40	PHILLIPS PETROLEUM Bartlesville, Okla.	Liquefied natural gas, chemicals, plastics	424.0	2.2	10,721.0	32	4.0	47
45	50	NCR Dayton	Computers, related products	410.8	18.8	5,640.7	74	7.3	43
46	45	ELI LILLY Indianapolis	Drugs, medical equip., agricultural prod.	386.3	4.5	4,049.3	111	9.5	34
47	38	DEERE Moline, Ill.	Farm and industrial equipment	385.0	-20.4	4,134.5	108	9.3	35
48	48	COMBUSTION ENGINEERING Stamford, Conn.	Steam generators and power plants	383.7	7.3	3,301.0	128	11.6	27
49	•	ETHYL Richmond	Specialty and petroleum chemicals	367.8	16.4	1,720.3	212	21.4	6
50	•	XEROX Stamford, Conn.	Copiers, printers, computer workstations	358.0	8.5	10,320.0	34	3.5	48
TOTALS			79,668.1		767,059.4				

TECHNOLOGY IN THE YEAR 2000

Only a dozen years ago there were no PCs, no CDs, no VCRs, no genetically engineered vaccines. The next 12 years could bring ten times as much progress. ■ by Gene Bylinsky

ALL IS VANITY, said the Preacher, and there is nothing new under the sun. Well, maybe there wasn't in the time of King Solomon, and anyway the author of Ecclesiastes was pondering the human condition, not man's evolution as toolmaker and healer. In these high-tech last days of the second millennium A.D., something new whizzes by practically every minute. In just the past dozen years the personal computer has transformed offices; videocassette recorders and compact discs have revolutionized home entertainment; and biotechnology has conferred genetically engineered vaccines and a host of other benefits on mankind. The next dozen years will bring the world to the year 2000. What further wonders are lurking in the labs today that will be commonplace when the next century begins?

"We'll see a minimum of ten times as much progress in the next 12 years as we've seen in the past 12," exults John Peers, president of Novix Inc., a Silicon Valley company that recently put a computer language on a chip to give new zip to communications-signal processing. He adds, "I wouldn't want to be a science fiction writer today because reality is leaping ahead of fantasy." Quite soberly Peers and his peers on the high-tech frontiers say that by the year 2000:

- Computers that don't look and act like computers will surround you—shirt-pocket and notebooklike devices that respond to handwritten and spoken queries and commands, maybe even gestures.

- In corporate research centers, supercomputers 1,000 times more powerful than today's will calculate electron interactions in molecules in order to create materials that never existed before.

- When you travel, you may carry along an electronic book that opens up to display text on two facing screens. The book's memory will contain as many as 200 novels

REPORTER ASSOCIATE Julianne Slovak

or nonfiction volumes; you just write the name of the one you want to read—and up it pops.

- Your doctor will check your heart by having you walk through a diagnostic machine rivaling Dr. McCoy's on *Star Trek*.

That's just a glimpse of the year 2000, when "we'll have capabilities no humans

ever had," says Ralph E. Gomory, senior vice president for science and technology at IBM. Gomory, 59, adds, "When my father was young, he used to take a horse-drawn carriage to the railroad station. There were no automobiles, no telephones, no movies. No airplane had ever flown. There was no television, no atomic bomb, no man on the



"THE JONESES ARE COMING FOR DINNER TOMORROW, SO PLEASE PREPARE CHICKEN KIEV FOR FOUR TO BE READY AT 8 O'CLOCK. AND REMIND ME WHAT MRS. JONES IS ALLERGIC TO."

"DIDN'T BILLY LOOK CUTE IN THAT NEW SWEATER TODAY? DOESN'T THIS NEW MAKEUP LOOK GREAT?"

The illustrations for this article were prepared on a personal computer using a version of Pixel Paint software that is not yet commercially available. The year 2000 could bring flat-screen TV with insets, book-size computers, electronic chefs that cook on command, and tiny picture phones.

moon. But by the time he died, he had flown in a jet and had seen all those other things happen. No generation had ever been through a transformation like that."

With all that has happened already, why are today's high-technologists so superconfident that the next 12 years will lead to a technological as well as a chronological millennium? What could possibly top all that has gone before?

The answer is that now, in contrast with earlier decades of invention, man stands at the dawn of the Age of Insight—a new era of understanding how things work and how to make them work better. In both electronics and biotechnology, the two principal fountainheads of new products, the immediate future holds not just the compilation of more and more data but also some startling new visions. In the view of many scientists, the computer is being transformed from a number cruncher into a machine for insight and discovery. It will become an instrument even more revolu-

tionary than the microscope or the telescope. Unlike those fabulous and still evolving tools, the computer can look into the future. Supercomputers do it already by forecasting weather a few days ahead. As they leap forward in power, by the year 2000 they will be forecasting the structures of new materials and simulating such cosmic phenomena as the evolution of stars and galaxies.

The new Age of Insight will also offer views of the workings of the human body never before attainable. Deciphering the interactions of the body's own healing substances and the underlying causes of disease will allow researchers to develop novel drugs and methods of treatment. They will increasingly tap the body itself as a new pharmacopeia, an almost inexhaustible trove of medications that genetic engineers can copy and improve on.

CONVERGING with these new insights and new computing power is the rapid emergence of telecommunications networks. It is as if—for a change—high-powered cars and sleek highways to accommodate them were arriving at the same time. Telecommunications experts see nothing less than a world linked by great computerized networks that process voice, data, and video with equal ease. The first ISDNs—integrated services digital networks—are just going into service in the U.S., Japan, and Western Europe. In a few years they are expected to yield billion-dollar annual savings to corporations in increased productivity and lowered communications costs.

The certainty of these advances makes the experts drool. "I've never been as excited about the future and about the speed with which we're making progress," says Gordon Bell, vice president for research and development at Ardent Computer of Sunnyvale, California, a maker of supercomputers. Bell is one of the world's top computer designers and visionaries: He led the development of Digital Equipment's landmark VAX computer systems. Now he is pioneering the new insight and discovery machines.

Most of the underlying technologies for products that will be on the market by the year 2000 are already in the labs or just entering them. Walter Utz, Hewlett-Packard's manager of advanced engineering, notes that it takes about 12 years to translate a new technology into useful products. Since the turn of the century is only 12 years

LOOKING AHEAD

away, many of the directions have already been set.

This article is based on an assessment of the future as a framework of the possible—as helicopter pioneer Igor Sikorsky once described it—by some 100 experts in industry, universities, federal agencies, and venture capital firms in the U.S., Western Europe, and Japan. Forty of these experts make up FORTUNE's Probability Panels, offering their predictions about the likelihood of specific innovations as shown in the accompanying tables. Surprises are bound to emerge along the way that may throw some of the predictions off track: Witness the recent surge in high-temperature superconducting materials. But, says IBM's Gomory, "forget the unexpected—the unexpected will just accelerate the progress. Believe me, we're having a revolution *without* superconductivity or anything like that."

A tour of what's coming by 2000:

THE EXPERTS AGREE that progress in both consumer electronics and computers will continue to be led by advances in semiconductor chips. These advances have been nothing short of spectacular, and they will continue to be so. Just 18 years ago Intel Corp. pioneered a 1,024-bit, or one-kilobit, DRAM (dynamic random access memory) chip, which held about 4,000 transistors and related components. Today, four-megabit—four-million-bit—DRAMs with about 16 million components are already in use.

"A one-billion-transistor chip by the year 2000 is not inconceivable," says Robert N. Noyce, vice chairman of Intel and co-inventor of the silicon chip. He thinks that a hundredfold, perhaps even a thousandfold, improvement is still possible with conventional technology, including so-called wafer-scale integration—building hundreds of different chips into a single system. Greater chip density makes chips cheaper and computers smaller and more reliable.

Along the way a new kind of information storage and processing technology may possibly emerge. One intriguing candidate: an optical liquid-crystal medium that would allow information to be stored in three dimensions, instead of the two dimensions of today's chips. This would permit the equivalent of thousands of memory chips to be jammed into a device the size of a coffee cup, says Caltech chip designer John Hopfield.

It's already clear that the galloping extension of today's technology will give

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TO REDUCE NOISE WITHOUT
CUTTING POWER."



To spoken commands, a computer reconfigures a jet-engine housing and submits it to tests.

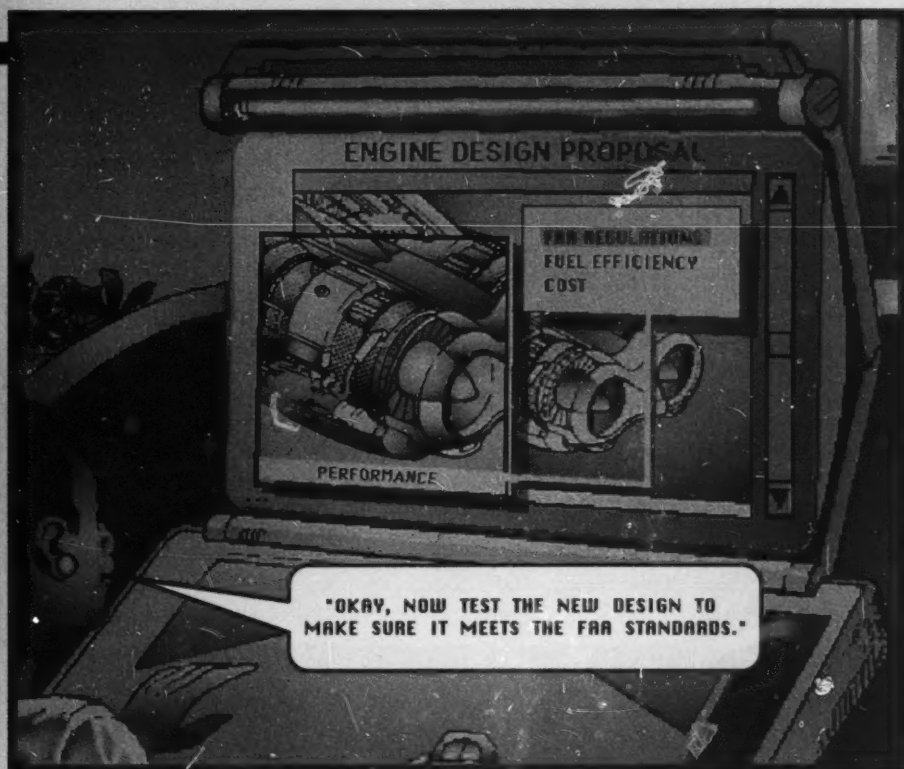
computers of the year 2000 an electronic punch that will startle today's users. Desktop workstations will pack the power of what we now know as supercomputers. Supercomputers themselves will soar into the numerical stratosphere—as will their cost. Supercomputers of the future are expected to do at least four trillion complex calculations a second—1,000 times more than today. The biggest may cost as much as \$1 billion, but that will represent a vast improvement in computing bang for the buck. A whole corporation might be built around a single supercomputing system.

One big challenge: devising appropriate software to run these supercomputers, which will likely consist of hundreds or even thousands of individual computers running in parallel. If that type of programming can be mastered, and most experts believe it will be, supercomputers will emerge as great vision- and intellect-extending engines by the year 2000. Kenneth G. Wilson, a Cornell University Nobel Prize winner in physics and an expert on supercomputing, predicts that the machines "will open vast new domains of scientific research—domains that are inaccessible to traditional experimental or theoretical modes of investigation." Supercomputers, he explains, will enable scientists to "see" objects on a smaller scale than microscopes can—a vital

contribution to chemistry, chemical engineering, molecular biology, and other fields. Supercomputers could also describe lightning-fast events, such as the chemistry involved in photosynthesis, in greater detail than today's instruments permit.

The supercomputer of the year 2000 will emerge as an indispensable industrial tool, because its enormous capacity will make possible mathematical modeling of complex phenomena that are influenced by huge numbers of variables. Among other things, it is likely to serve by then as a full-fledged electronic wind tunnel. Where today only portions of airplanes can be tested in computers, complete airframes will be "flown" inside supercomputers at supersonic and hypersonic speeds. Better cars will be designed in computers because an engineer will be able to "feel" how a car handles before it is built. On the screen the designer could repeatedly crash his computer-model car into barriers or other cars to see how well it withstands the damage.

The design of new materials should benefit spectacularly from the new supercomputer power. "Scientists have so far explored only an infinitesimal fraction of possible forms of matter," says Wilson. Since the properties and structure of molecules are ultimately determined by the interactions of the electrons within them,



In this Apple Computer concept, a design could be proved out without building a prototype.

Wilson says, sufficiently powerful supercomputers should theoretically be able to "predict everything about a material with no experimental information whatsoever" by calculating those interactions. He adds, "The potential importance for both basic research and industry applications is beyond anything one can imagine today, if reliability could be achieved."

The discovery capabilities of computers of all sizes will be enhanced by the great leap in computing power by the year 2000. The reason: the advent of what scientists have begun to call "visual computing," which in effect reproduces reality mathematically within a computer so that objects can be both seen and manipulated in all sorts of ways. The nature and behavior of an object or phenomenon can be described in equations and presented visually; the objects simulated can include anything from the steering mechanism of a car to the interior of a star. This kind of computing will open up new areas to scientific inquiry and bring products to market at unheard-of speeds by allowing the rapid testing of almost infinite product variations.

Visual computing makes seeing become believing. It gives engineers and scientists a new window into complex realities. As Donald P. Greenberg, director of the computer graphics program at Cornell, explains

it: "I don't care whether we're traveling down the bloodstream and inside the heart, or looking at a building shaking in a simulated earthquake, or at an interior design of a house, or at a demographic projection with six variables. I just want to see what's happening so that if my model does not yield the results I anticipated, or if the interrelationships between the variables are incorrect, I can go back and change the simulation."

Another great benefit of soaring computing power will be the arrival of the truly "user friendly" computer. A great gap still separates man and machine. Despite their computational brilliance, which dwarfs man's, machines have horrendous difficulty with speech recognition because people

speak in unstructured and inconsistent ways. Computers have comparable problems identifying visual patterns and recognizing objects from varying angles.

To the rescue, by the year 2000, may come neural circuits, simplified analogs of much more complex human auditory and visual nerves and related structures. One of those unpredictable twists in the high-tech road to the future may be a \$2,000 board for PCs that will allow them to understand several hundred words of continuous speech. The board, which Digitech Inc., a small Missouri company, says it will deliver by the end of this year, uses chips that try to imitate some of the ear's sound-processing functions. Similar work is in progress in vision. Caltech's noted microchip designer Carver Mead, for instance, has already built a chip that imitates some of the eye's information processing.

By putting some of these ideas into practice, says Jean-Louis Gassée, Apple Computer's senior vice president for research and development, "by the year 2000 computers will seem magic to my wife, who really doesn't like computers." The day may well have come when machines respond readily to spoken commands—and even answer back, just as the strong-willed HAL-9000 computer did in the 20-year-old film *2001: A Space Odyssey*.

BY THE YEAR 2000 most computers will have lost their familiar boxy shapes. The idea is to make them more compatible with people by making them look less like machines. Says Gomory: "One way to make computers easy to use is to pretend there is no computer. Instead, you reproduce on the screen whatever you're used to. If you want to write a letter, you reproduce a piece of paper on the screen and you write on it. The computer translates your handwriting into type. If you want to file the letter, a

A FORTUNE PROBABILITY PANEL

COMPUTERS

Ten experts in industry, universities, and government agencies rate on a scale of 1 to 10 the likelihood that each item listed will be available by the year 2000.

	TEN EXPERTS										CONSENSUS
Computers that recognize handwriting ..	7	9	9	8	8	9	9	4	9	7	7.9
Instant access to all available information on a subject	9	9	7	8	10	8	3	9	4	4	7.1
Voice-controlled computers	5	3	1	3	10	9	9	10	8	9	6.7
Gesture-controlled computers	3	8	8	6	10	1	9	10	7	3	6.5
Flat desktop computers	8	6	2	5	10	5	9	7	5	5	6.2

LOOKING AHEAD

picture of a filing cabinet appears and you stick the letter in."

Handwriting as a means of entering data into computers, in fact, tops the list of many experts' predictions. They feel it is a more natural way to interact with computers than using keyboards, even though some people can type faster than they write and others have messy handwriting. The writing would be done on thin flat screens placed on desks, much like blotters.

Companies are hard at work on putting these concepts into practice. IBM, for one, is developing components of an electronic book that would contain the text and illustrations from hundreds of volumes on a small diskette, with an easy-to-read liquid-crystal screen instead of pages. "We could even give it to you in a leather binding, if you prefer," says Gomory. In addition, it

could be used as a computerized workbook, a small machine for word processing and other applications that a traveler could carry along and communicate with in long-hand instead of using a keyboard or a mouse. Texas Instruments is also exploring the idea.

MITCHELL KAPOR designed the Lotus 1-2-3 spreadsheet programs and is now chairman of On Technology Inc., a Cambridge, Massachusetts, software company. He sees almost all PCs assuming the shape of hard-cover books in the year 2000. He predicts the appearance of a computer-based reference book, a cross between a dictionary and an encyclopedia, that answers questions about people, places, and events. Gassée of Apple envisions comput-

ers of many sizes—from a 3-by-5-inch card to a blackboard tapped into a database. Noyce of Intel expects to see a personalized electronic file by the year 2000. He describes this device as "a filing system that will read and recall every piece of information that comes across my desk, or that I deal with in my daily activity." The device, furthermore, would have "instant communication with every other computer." The function of computers will also change dramatically. They will, in essence, become instruments of access to a network over which desired information flows rapidly on demand.

Telecommunications are converging with computers at an opportune time. Just as computational capabilities are beginning to soar, the telecommunications industry is rapidly switching from analog to digital



An executive uses Apple's projected Knowledge Navigator, combining an interactive talking computer with advanced telecommunications.

A FORTUNE PROBABILITY PANEL

TELECOMMUNICATIONS

The experts give all these possible products a good chance to be on the market in 12 years except the instantaneous-translation telephone, a Japanese dream machine.

	TEN EXPERTS										CONSENSUS
Voice-controlled telephones	5	8	8	10	7	8	9	10	5	8	7.8
Color fax	8	8	4	10	7	6	6	10	10	8	7.7
Combined telephone/computer/TV	9	5	8	4	8	7	8	8	2	9	6.8
Picture phones	3	4	6	7	5	6	9	10	8	8	6.6
Instantaneous-translation telephones	4	4	5	3	3	3	3	5	1	6	3.7

transmission of signals—the “bit” language of computers. Furthermore, the industry is greatly enhancing the transmission capacity of existing telephone lines to allow simultaneous transmission of voice, data, and video. A few years further in the future is wide use of capacious fiber-optic cables in business and at home. Cassée calls such a cable “a data hydrant.”

The telephone of the year 2000 will evolve into what Bell Labs’ vice president for research, Arno A. Penzias, refers to as “an integrated information appliance.” This would be a sleek device with a large flat screen that would allow picture-phone conferences in full color as well as offer all the other accouterments of the information age: the ability to send and receive documents and messages, act as a full-size computer, and provide access to many information sources.

ROLAND C. MORENO, president of Paris-based Innovatron and inventor of a “smart” credit-and-charge card equipped with a chip, sees counterparts of the French Minitel system in wide use in other countries by the turn of the century. (West Germany’s Bundespost, the federal postal service, is now expanding its version of the system.) Minitel replaces telephone books with a small computer terminal. Besides finding addresses, it can buy theater, plane, and train tickets, send bouquets of flowers with notes translated if need be—albeit clumsily—and find girlfriends or boyfriends, the machine’s most popular service. Minitel is now in use in nearly four million French households and offices as a government-subsidized experiment.

Japan’s entry in the future-telephone derby is likely to be an instantaneous translation telephone that will work at least in English and Japanese, for openers. NEC, the Japanese electronics giant, began research on the project in 1983. Akihiro Kitamura, a NEC vice president, says it will take at minimum another five to ten years

to complete the device—assuming the problem of recognizing continuous speech will have been mastered by then.

The Age of Insight is also revolutionizing both medical diagnosis and treatment by making them far quicker and more specific. An imposing array of new tests and instrumentation—from antibodies that seek out harmful viruses and bacteria to vastly improved body-scanning technologies—are opening the interior of the body to a new view. All this should allow doctors to diagnose infections in minutes instead of days and heart attacks in seconds instead of hours. They should also be able to detect tumors before symptoms appear, permitting treatment to begin earlier and drastically improving the chance of success.

New insights into human diseases would spur the creation of elegant new treatments. For instance, Leroy Hood, a brilliant Caltech immunologist, says that by the year 2000 it should be essentially possible to prevent such autoimmune diseases as rheumatoid arthritis, multiple sclerosis, and insulin-dependent diabetes, in which the body mistakenly attacks its own tissue. Clones of immune system cells gone haywire do the damage. Hood and his associates are already designing ways to remove such undesirable cell families in mice.

One of the experts’ most startling predictions is that by the year 2000 it should be possible to regrow whole organs, or parts of them, in the body instead of replacing them

with transplants. This could come about in at least two ways. First, scientists could decipher the remarkable biological program that leads to the growth of a new heart in an embryo, for example. Second, they could repair sections of a heart that had been damaged by a heart attack, say, by administering such tissue-restoring substances as the fibroblast growth factor that the body makes to regenerate blood vessels. California Biotechnology Inc., of Mountain View, the first company to clone the factor, has shown that it significantly accelerates the healing of wounds in animals; tests on people start next year. The growth factor also appears to repair nerve cells such as those destroyed in the brains of Alzheimer’s victims.

BY EXTRACTING such healing substances from the human body and duplicating them through genetic engineering, scientists are cashing in on—and enhancing—the body’s remarkable ability to heal itself. Genetic engineers have hit a potential bonanza: The body makes about 100,000 proteins. Says David Botstein, vice president for science at Genentech, the biggest U.S. biotech company: “Suppose 1% of them have the potential of being turned into pharmaceuticals. That’s 1,000 new drugs.” Other drugs of the year 2000 should include inexpensive and highly specific molecules tailored to fit receptors for hormones, peptides, and other substances that regulate physiological events in the body from hunger to the sex drive. These precisely targeted drugs will replace chemicals discovered by the historical trial-and-error method. Genetically engineered vaccines, such as the recently introduced hepatitis killer, could eradicate many infectious diseases, including malaria.

This century’s crowning achievement in biology could well turn out to be the deciphering of the human genome—the deter-

A FORTUNE PROBABILITY PANEL

BIOTECHNOLOGY & MEDICINE

The medical experts give an AIDS vaccine by the year 2000 less than an even chance, but quicker diagnosis and better treatment should limit damage from heart attacks.

	TEN EXPERTS										CONSENSUS
Defeat of heart disease	7	10	6	7	8	0	4	3	6	2	5.3
Defeat of AIDS virus	5	2	3	5	8	10	1	5	7	2	4.8
Defeat of rheumatoid arthritis and multiple sclerosis	8	5	5	5	2	6	5	0	6	3	4.5
Defeat of leukemia and lung cancer	6	5	5	5	4	2	3	0	2	1	3.3
Defeat of Alzheimer’s and Parkinson’s	3	2	4	1	1	2	0	2	0	0	1.5

LOOKING AHEAD

mination of the order, content, and location of the genes on the human chromosomes that control the body's growth and well-being. Broken down to the most basic chemical level, says Hood of Caltech, those instructions would fill 500 volumes, each 1,000 pages long, each page containing 1,000 words, each word consisting of six letters of the DNA language. The mapping of the genome would open broad new avenues of medical diagnosis and treatment. In basic biology, comparative analysis of the genomes of mice, fruit flies, and people would allow scientists to break the other two still undeciphered DNA codes—one that dictates steps in cell differentiation and development, another that governs the structure of chromosomes.

CRACKING the remaining codes, Hood suggests, would raise the spectacular possibility of creating entirely new types of biostructures for medical and industrial uses. A molecule might be designed, for instance, that would connect with cancerous cells and make them revert to normal. Deciphering the genome would also allow doctors to prepare a genetic printout of a baby at birth to spot

susceptibility to various diseases and to start early treatment.

Surprisingly, FORTUNE's Probability Panel doubts that the most talked-about recent scientific breakthrough—superconductivity—will contribute much by the year 2000. The phenomenon greatly speeds the flow of electrons by cooling the conductors they pass through—to the point where they lose resistance. But Ian Ross, president of Bell Labs, says that while superconductivity is of great interest in instrumentation, working at extremely low temperatures in computing and signal switching is "too irksome." Chairman Gordon Moore of Intel adds that he is always suspicious of new technologies "where everybody seems to be excited about it for

somebody else's application. You know, 'My view is that it doesn't impact the kinds of things we do much but the power generation people will find it great.'"

AT IBM, Gomory draws a sharp distinction between new superconducting materials as scientific discoveries and their possible technological applications. He says, "A door has been opened into the unknown and we don't know what's on the other side. We're in a whole new world of materials. History has shown us that over time that tends to amount to something." But he guesses that most of those breathless forecasts about superconductivity powering 300-mile-per-hour trains and carrying electricity cheaply over long distances probably won't come true.

The impact of new technology on everyday work and life in the year 2000 will be more subtle than the dramatic transformations wrought in the lifetime of Gomory's father by automobiles, airplanes, movies, antibiotics, television, spaceflight, and other marvels. Some of the changes computers will bring about will be more intellectual in content, while in biotechnology the great advances in diagnostics and treatment will be readily apparent. Says George H. Heilmeier, chief technical officer at Texas Instruments: "In the medical field alone, the ability to bring the best medical care in the world to any local hospital will represent as big a jump as going from the horse-drawn cart to the automobile."

There are limits, of course. None of the technological possibilities that scientists and engineers are pursuing today suggest that man will soon decipher such fundamental mysteries as the workings of the human mind or the fate of the universe. Ecclesiastes also declared, "No man can find out the work that God maketh from the beginning to the end." The Preacher may not have been right about new things under the sun, but on this one he hasn't been proved wrong—yet. **F**

A FORTUNE PROBABILITY PANEL

SUPERCONDUCTIVITY

These experts think the technology is likely to improve magnets and motors, but doubt that such things as magnetically levitating trains will soon be a commercial reality.

TEN EXPERTS

CONSENSUS

Magnets	5	7	8	4	7	7	7	6	1	7	5.9
Motors and generators	5	7	7	6	7	7	8	5	0	5	5.7
Energy storage	4	7	4	4	8	4	4	5	0	5	4.5
Power transmission	4	2	4	5	2	4	5	4	0	5	3.5
Levitating transportation	4	2	6	2	1	2	2	2	0	2	2.3



Vastly improved body-scanning techniques will aid both diagnostic and surgical accuracy.

LETTERS

al freedom, leaving a legacy that all work is God's work. How profoundly our culture used to be influenced by that credo.

YVONNE DODD
Dallas

Myron Magnet dares question values from the Sixties that many of us thought were "in." Yet the "cultural revolution" of the Sixties was merely another wave of a trend that began with the French Revolution: the breakdown of loyalty and discipline in the West.

SIEGFRIED P. DURAY-BITO
Chief Financial Officer
Schneider Securities
Denver

I read the essay twice. It is a brilliant analysis and should be required reading of every high school and college student in the country. Perhaps more important, it should be required reading of all the teachers in those institutions. There is no substitute for values.

RICHARD A. YOUNG
Martin Clearwater & Bell
New York City

BURNING OUT IN THE OIL FIELD

"Cool Cures for Burnout" (June 20) hit the nail square on the head. I'm a front-line manager for an oil-field services firm, and burnout is a major problem in our business—although it is usually called a bad attitude. We are an industry slowly bleeding to death, but unlike IBM, we don't have the resources to stop the flow.

AUBREY MERKEL
Bryan, Texas

THE TRADE PUZZLE

I am amazed by the debate over why the U.S. trade deficit is slow to decrease despite the dollar's drop against foreign currencies ("The New Export Entrepreneurs," June 6). Foreign companies might be applying this principle: Never lose a customer. Some companies might not be able to keep it up, but those that do—and I believe it will be the majority—will turn out to be the toughest competitors U.S. industry has ever faced.

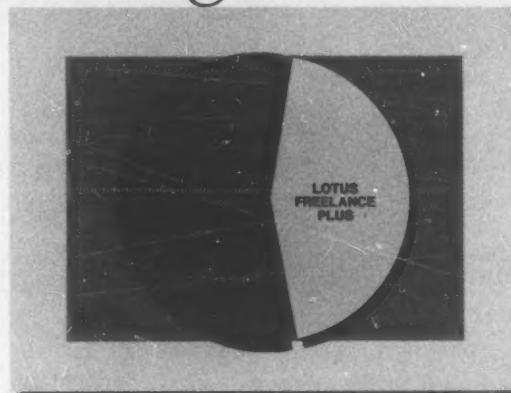
M. H. DE GRAEF
Geneva, Switzerland

CORRECTION

In "The Wacky, Wacky World of CEO Pay" (June 6), Ted C. Wetterau of Wetterau Inc. was incorrectly ranked as a result of erroneous salary information. He should have appeared as No. 103 among those making less than "rational" pay. □

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